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"Note on the Spectrum of Silicium." By Sir NORMAN LOCKYER, K.C.B., F.R.S. Received November 9—Read November 23, 1899.

In 1895, during the course of an investigation of the spectra of gases distilled from the mineral Eliasite, a double line at λλ 4128·3 and 4131·4 was found in one of the photographs, which could not at the time be traced to any terrestrial substance. It was thought that it might belong to some new gas, especially as there was a well-marked double in the corresponding region of α Cygni.

Some time later, shortly after the discovery by Professor Pickering of a new series of probable hydrogen lines in the spectrum of ζ Puppis, an attempt was made to produce this series of lines in the laboratory, and the spectrum of hydrogen was examined under different electrical conditions. During this research it was found that with the use of the spark in vacuum tubes of very narrow bore, with large jars in circuit, the same double line noted in the eliasite photograph made its appearance, and as in these experiments the glass on the inside of the capillary of the vacuum tube had become partially fused, silicium suggested itself as being the origin of this so-called "unknown" double. That this was correct was proved directly afterwards by photographing the spectrum of a spark over SiO_2 in a retort, the double in question being the most prominent feature of the spectrum.*

In addition to this double, a wider one at λλ 3856·1 and 3862·7 was noticed, and as the two components also agreed very closely in position with lines in the spectrum of α Cygni, it was concluded that silicium was the true origin of the lines.†

* A list of the spark lines of silicium was published by Eder and Valenta in 1893, and the identity of the strange double would probably have been established before by a reference to that list, had it not been for a large error in the wave-length of one of the components of the double as recorded by them.

† The probable explanation of the appearance of the silicium double in one of the photographs of the spectrum of the eliasite gases is that one of the platinum

Very few records of work on the silicium spectrum have been published by later spectroscopists, but Eder and Valenta* give lines agreeing in wave-length with those mentioned, as shown in the accompanying table.

λ. (Lockyer).	Int.	λ. (Eder and Valenta).	Int.	Remarks.
3856·1	6	3855·7	3	
3862·7	4	3862·5	3	
4128·1	3	4126·5	4	Probably a misprint for 4128·5.
4131·1	4	4131·5	4	

Later experiments on the spark spectrum of silicium with the aid of the large Spottiswoode coil, and on the spectra of silicium compounds in vacuum tubes, reveal other lines of that element no less interesting from a stellar point of view than those previously mentioned.

We learn from these recent observations that the lines of silicium may be divided into three sets, no two of which behave alike under varying electrical conditions. The wave-lengths of the lines composing the different sets are:—

$$\left.\begin{matrix}3856{\cdot}1\\3862{\cdot}7\\4128{\cdot}1\\4131{\cdot}1\end{matrix}\right\}\text{A.}\qquad \left.\begin{matrix}4089{\cdot}1\\4116{\cdot}4\end{matrix}\right\}\text{B.}\qquad \left.\begin{matrix}4552{\cdot}8\\4568{\cdot}0\\4575{\cdot}3\end{matrix}\right\}\text{C.}$$

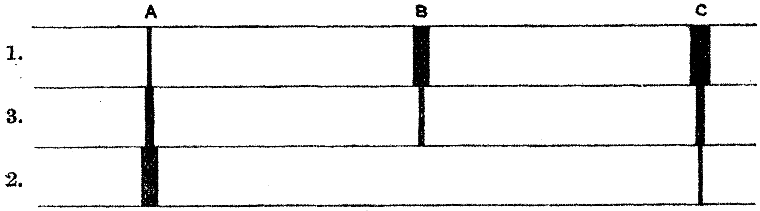
There is a line at λ 3905·8 which is associated in the spark spectrum of silicium with the lines in set A, but while these are entirely absent from the arc spectrum of silicium, 3905·8 is a strong line in the arc spectrum. This line differs from the others, therefore, in not being enhanced in intensity in passing from the conditions of the arc to those of the spark. So far as is known, the lines in sets B and C have not been recorded by any other observers of the silicium spectrum.

The behaviour of the three sets of lines in terrestrial spectra is shown in the following figure.

It is found, on investigating the occurrence of these silicium lines in stellar spectra, that the three sets of lines respectively attain a maximum intensity at the three different levels of stellar temperature represented by β, γ, and ζ Orionis.

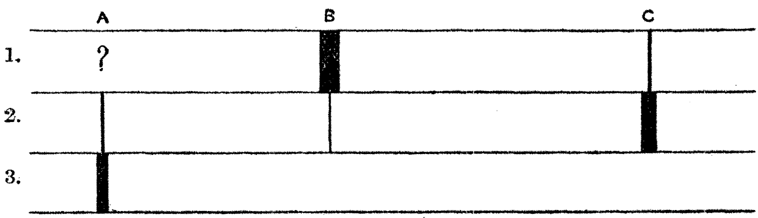
poles of the "steeple" used in that particular case had broken off close to the glass, and the latter was fused by the heat from the spark. This is the more likely as the double line only appeared on one edge of the spectrum.

* 'Denkschr. Kais. Akad. Wissensch., Wien.,' vol. 60, 1893.



1. SiF_4 vacuum tube (capillary).
2. SiO_2 spark with Spottiswoode coil.
3. Vacuum tube (bulb) SiO_2 spark with small coil.

The accompanying figure shows the behaviour of the different sets A, B, and C in the spectra of β, γ, ζ Orionis.



1. ζ Orionis.
2. γ Orionis.
3. β Orionis.

We find that set A is most prominent in the spectrum of β Orionis, that set C predominates in the spectrum of γ Orionis, and that set B is by far the strongest in that of ζ Orionis.

That the stars named represent three different grades of temperature, ζ Orionis being the hottest, and β Orionis the coolest, has been previously deduced by the discussion of other lines in their spectra. This result was embodied in a paper "On the Order of Appearance of Chemical Substances at different Stellar Temperatures," which I read to the Society in February of the present year. In that paper α Crucis was given as a typical star representing a stage of temperature between those of β Orionis and ζ Orionis. That star can be very well replaced for the purpose of the present discussion by γ Orionis, the two spectra being nearly identical.

The line at λ 3905·8 previously mentioned as occurring in both arc and spark spectra, is not represented in the spectra of any of these stars. It is possibly present in the spectra of stars like the sun, as Rowland records it in his "Preliminary Table of Solar Spectrum Wavelengths," as being coincident with the well-marked Fraunhofer line at λ 3905·660. This coincidence, however, is open to doubt; from a comparison of the Rowland grating photographs of the silicium spark

spectrum and the solar spectrum taken at Kensington, the silicium line apparently agrees better in position with the less refrangible edge of the solar line than with the middle.

Before this point can be definitely settled, still larger dispersion will have to be employed.

In the paper mentioned, it was shown that silicium made its appearance first at the temperature represented by α Ursæ Minoris, and strengthened at the higher temperature of α Cygni and β Orionis, afterwards weakening as we pass through the still higher temperatures of ζ Tauri and γ Orionis, until at the ζ Orionis stage it is bordering on extinction.

In the same paper the behaviour of a line at λ 4089·2 was plotted, and at the same time it was quoted as an "unknown" line.

It is interesting to note that this line is now traced to silicium, and is the strongest line in set B. It is apparently a short-lived line in stellar spectra, as it only occurs between the stages of temperature represented by γ Orionis and ζ Orionis, being one of the weakest lines in the spectrum of the former star, and one of the strongest in that of the latter.

Most of the photographs of the silicium spectrum under varying conditions were taken by Mr. Butler. The wave-lengths of the lines have been reduced by Mr. Baxandall, and he is also responsible for establishing the identity of the terrestrial and the stellar lines. My thanks are due to him also for help in the preparation of the present communication.

"Preliminary Table of Wave-lengths of Enhanced Lines." By Sir NORMAN LOCKYER, K.C.B., F.R.S. Received November 9,—Read November 23, 1899.

Introduction.

In the year 1881 I communicated a paper* to the Royal Society in which I described some experiments relating to the brightening of some lines in the spectrum of iron on passing from the arc to the spark.

It was found that in the case of iron, the two lines in the visible spectrum at λ 4924·1 and λ 5018·6, on Rowland's scale, were greatly enhanced in brightness, and were very important in solar phenomena.

The work was subsequently carried into the photographic region of the spectrum with very interesting results, since it was found that several other lines were enhanced at the highest temperature I could then obtain.

In a later paper† I described the results obtained in further photo-

* 'Roy. Soc. Proc.,' 1881, vol. 32, p. 204.

† 'Roy. Soc. Proc.,' vol. 61, p. 158.